

What is claimed is;

1. An image processing method for implementing low-pass filtering on image data, comprising:

a similarity judging step in which similarity among
5 pixels are judged along at least four directions in a local area containing a target pixel undergoing low-pass filtering processing; and

2. a direction-dependent low-pass filtering step of performing a weighted averaging operation in which
10 weighted pixel values of pixels around the target pixel are added to the pixel value of said target pixel and the result of addition is divided by the sum of the weights, a weighting rate along a direction manifesting marked similarity becoming increased based upon judgement
15 obtained in said similarity judging step.

2. An image processing method according to claim 1, wherein:

in said similarity judging step, said similarity is
20 judged by using either one or both of the characteristics differences in (1) and (2) below;

(1) characteristics differences among a plurality of pixels located on lines passing through said target pixel along specific directions;

25 (2) characteristics differences among a plurality of

~~pixels located on lines passing near the target pixel
along specific directions.~~

3. An image processing method according to claim 2,

5 wherein:

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said characteristics differences among pixels are
calculated as absolute values of differences among pixel
values of a plurality of pixels within said local area;

in said similarity judging step;

10 first similarity values $tt1$, $yy1$, $nu1$ and $ns1$ along
at least four directions are calculated using absolute
values of the differences in either said (1) or said (2)
or absolute values of the differences in both said (1) and
said (2);

15 a representative value $m1$ of said first similarity
values is calculated by averaging or taking a median of
said first similarity values $tt1$, $yy1$, $nu1$ and $ns1$ along
at least four directions; and

nonlinear conversion below is executed based upon
20 said first similarity values $tt1$, $yy1$, $nu1$ and $ns1$ along
at least four directions and said representative value $m1$
to calculate second similarity values $tt2$, $yy2$, $nu2$ and
 $ns2$:

25 $tt2 = \max \{m1 - tt1 + \delta, \gamma\} \dots (\text{expression 1})$

yy2 = max {m1 - yy1 + δ , γ } ... (expression 2)

nu2 = max {m1 - nu1 + δ , γ } ... (expression 3)

ns2 = max {m1 - ns1 + δ , γ } ... (expression 4)

5 (where δ and γ in the expressions above each represents a predetermined value which may be 0); and

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in said direction-dependent low-pass filtering step,
weighting rates for neighboring pixels located along at
least four directions are determined in correspondence to
10 said second similarity values tt2, yy2, nu2 and ns2 that
have been calculated, the pixel values of pixels around
the target pixel are weighted by said weighting rates,
pixel values thus weighted are added to the pixel value of
said target pixel and then the result of addition is
15 divided by the sum of the weights.

4. An image processing method according to claim 1,
wherein:

said image data are color image data; and
20 said similarity is judged based upon at least two
types of color information in said color image data in
said similarity judging step.

5. An image processing method according to claim 4,
25 wherein:

~~Said similarity is judged based upon color image data yet to undergo interpolation processing in said similarity judging step.~~

5 6. An image processing method according to claim 4, wherein:

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said first similarity values along specific directions are calculated by using characteristics differences among a plurality of same color pixels and/or
10 a plurality of different color pixels along the specific directions and similarity is judged in correspondence to said first similarity values that have been calculated in said similarity judging step.

15 7. An image processing method according to claim 6, wherein:

characteristics differences among a plurality of different color pixels are calculated based upon color image data having undergone white balance processing in
20 said similarity judging step.

8. An image processing method according to claim 6, wherein:

a degree of saturation is detected with regard to
25 said target pixel undergoing low-pass filtering processing

~~and contribution factors of characteristics differences of~~
a plurality of different color pixels are varied in
correspondence to said degree of saturation that has been
detected when calculating said first similarity values in
5 said similarity judging step.

9. An image processing method according to claim 1,
wherein:

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10 said image data are image data having undergone
interpolation processing to interpolate pixels with
missing color components; and

said low-pass filtering processing is implemented
only on target pixels having undergone said interpolation
processing in said direction-dependent low-pass filtering
15 step.

10. An image processing method according to claim 1,
wherein:

20 said image data are image data having undergone
interpolation processing to interpolate pixels with
missing color components; and

a pixel value of each pixel having undergone said
interpolation processing is limited by a threshold value
corresponding to a largest pixel value or a smallest pixel
25 value in a specific area near the corresponding pixel

~~prior to the low-pass filtering processing in the
similarity judging step.~~

11. An image processing method according to claim 1,

5 Wherein:

said image data are color image data having, at least,
a first color with a highest pixel density and a second
color with a low pixel density and vacancies of color
information, said image processing method further
10 comprising:

a color difference calculating step in which a color
difference between said second color and said first color
is obtained for each pixel at which said second color is
present;

15 a color difference interpolating step in which a
color difference interpolation value is obtained for a
pixel at which said second color is not present based upon
said color difference obtained in said color difference
calculating step; and

20 a second color restoring step in which said second
color is restored based upon said color difference
interpolation value obtained in said color difference
interpolating step and a pixel value of said first color,
wherein:

25 said first color used to calculate said color

difference in said color difference calculating step is
said first color that has not undergone said low-pass
filtering processing.

5 12. An image processing method according to claim 11,
wherein:

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said first color used in restoring said second color
in said second color restoring step is said first color
that has undergone said low-pass filtering processing.

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13. An image processing method according to claim 11,
wherein:

weighting rates are obtained based upon said first
color and weighted averaging is performed for said second
15 color or said color difference using said weighting rates
in said direction-dependent low-pass filtering step.

14. An image processing method according to claim 1,
wherein:

20 a weighting rate along, at least, a direction
manifesting a least degree of similarity is set
substantially to 0 in said direction-dependent low-pass
filtering step.

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25 ~~15. An image processing method according to claim 1,~~

wherein:

said image data are generated by performing color separation in which reflected light from an object is captured with color filters arranged in a Bayer array; and

5 in said similarity judging step, a judgment is made on said similarity manifesting in said image data constituted of color separated R, G and B pixel data in an original state, G color image data generated by using said image data or brightness image data generated by using
10 said image data in said similarity judging step.

16. An image processing method according to claim 15, wherein

in said low-pass filtering step, low-pass filtering
15 is implemented on G color image data generated from said image data, R color image data generated from said image data, the B color image data generated from said image data, brightness image data generated from said image data or color difference between individual RGB colors
20 ~~generated from said image data based upon said similarity~~ determined in said similarity judging step.

17. An image processing apparatus that implements, at least, low-pass filtering on image data, comprising:

25 a means for similarity judgment that judges

similarity among pixels along at least four directions in a local area containing a target pixel undergoing low-pass filtering processing; and

a means for direction-dependent low-pass filtering
5 that performs a weighted averaging operation in which weighted pixel values of pixels around the target pixel are added to the pixel value of said target pixel and the result of addition is divided by the sum of the weights, a weighting rate along a direction manifesting marked
10 similarity becoming increased based upon judgement obtained by said means for similarity judgment.

18. An electronic camera that implements, at least, low-pass filtering on image data obtained through image
15 capturing, comprising:

a means for similarity judgment that judges similarity among pixels along at least four directions in a local area containing a target pixel undergoing low-pass filtering processing; and

20 a means for direction-dependent low-pass filtering that performs a weighted averaging operation in which weighted pixel values of pixels around the target pixel are added to the pixel value of said target pixel and the result of addition is divided by the sum of the weights, a
25 weighting rate along a direction manifesting marked

similarity becoming increased based upon judgement
obtained by said means for similarity judgment.

19. A recording medium readable on a computer recording
5 an image processing program for executing:

a similarity judging step in which similarity among
pixels are judged along at least four directions in a
local area containing a target pixel to undergo low-pass
filtering; and

10 a direction-dependent low-pass filtering step of
performing a weighted averaging operation in which
weighted pixel values of pixels around the target pixel
are added to the pixel value of said target pixel and the
result of addition is divided by the sum of the weights, a
15 weighting rate along a direction manifesting marked
similarity becoming increased based upon judgement
obtained in said similarity judging step.

20. A data signal that transmits via a transmission
20 line an image processing program for executing:

a similarity judging step in which similarity among
pixels are judged along at least four directions in a
local area containing a target pixel to undergo low-pass
filtering; and

25 a direction-dependent low-pass filtering step of

performing a weighted averaging operation in which
weighted pixel values of pixels around the target pixel
are added to the pixel value of said target pixel and the
result of addition is divided by the sum of the weights, a
5 weighting rate along a direction manifesting marked
similarity becoming increased based upon judgement
obtained in said similarity judging step.

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